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ABSTRACT

Earlier research (Thorson, et al., 1976) found that latencies increase for acoustically confusable letter pairs and decrease for visually confusable letter pairs as a positive function of interstimulus interval (ISI). To extend these findings to different age groups, 30 young adults (mean age, 21.4 years) and 30 older adults (mean age, 68.8 years) compared the same pairs of visually and acoustically confusable letters, with a varying ISI between 0.0 and 2.5 seconds, at 0.5 second intervals. An analysis of the results showed fewer errors for the young adults than for the older adults. For ISIs above 0.0, slope for young adults was almost flat and ISIs were similar for both conditions of confusability. Latencies for older adults were longer for visually than for acoustically confusable letters at ISIs less than 2.5 seconds. These findings support acoustic encoding as an optional process and suggest that older people retain information in a visual code rather than transferring it to an acoustic code. Young adults appear able to select the appropriate code at all intervals. (Author/BL)

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Visual and Acoustic Encoding in Young and Old Adults

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Abstract

In a matching task, pairs of visually (XY) and acoustically (XS) confusable letters were sequentially presented to 30 young (X=21.4) and 30 old (X=68.8) adults. Interstimulus interval (ISI) was varied between 0.0 and 2.5 seconds at intervals of 0.5 seconds. For ISIs above 0.0, slope for young adults was almost flat and ISIs were similar for both conditions of confusability. Latencies for older adults were longer for visually than for acoustically confusable letters at ISIs < 2.5 seconds. Results support acoustic encoding as an optional process and suggest that older people retained information in a visual code rather than transferring it to an acoustic code, while young adults appeared able to select the appropriate code at all intervals.

In a seminal experiment, Posner, Boies, Eichelman, and Taylor (1969) asked subjects to judge whether pairs of sequentially presented letters were the same or different. The pairs of letters were of two kinds, physical identity matches (AA), in which judgements could be made solely on the basis of visual information, and name matches (Aa), which required acoustic encoding in order to determine whether or not the letters matched. Posner et al. found that when the interval between the presentation of the two letters was very short, judgements were faster for identity matches than for name matches, but as the interstimulus interval (ISI) was increased, the advantage of the physical identity matches disappeared. They interpreted these results as evidence that information is first retained in a visual code, which rapidly decays and is replaced by an acoustic code.

Using a similar procedure, Thorson, Hochhaus, and Stanners (1976), varied the ISI between sequentially presented pairs of visually confusable (XY) and accoustically confusable (XS) letters. They reasoned that it would take longer to discriminate between visually confusable letters at short ISIs while the letters were encoded in a visual mode, and that it would take longer to discriminate between accoustically confusable letters at longer ISIs after an acoustic code had been generated. As predicted, Thorson et al. found that as the ISI was increased by intervals of .5 seconds to a maximum of 2.0 seconds, the latency

for distinguishing between visually confusable letters decreased as a function of the ISI and the reverse was true for accoustically confusable letters.

The present study was a replication of the Thorson et al. (1976) study with two age-groups of adults, a young group and an old group. The purpose was to investigate age differences in the time course of visual and acoustic encoding. According to Posner (1978), the generation of both visual and acoustic codes from visually presented familiar symbols, such as digits or letters is an automatic process. Hoyer and Plude (1980) have suggested that age related slowing should not occur in those processes which are processed automatically, but only in those which require effort. This would suggest that the two age groups should differ only in intercept, reflecting increased time for decision making and for the motor response, but not in slope which, reflects encoding time. Thus, if encoding is an automatic process and if age-related slowing does not occur in automatic processes, Thorson's results should be replicated for both age groups. A decrease in latency as a positive function of the ISI for visually confusable letters, and a corresponding increase for acoustically confusable letters should be seen for both age groups.

Hines, Poon, Cerella, and Fozard (1982) have used a Posner technique to compare the time course of encoding digits for young and old adults. Although they did not investigate modality

differences, they found a difference in slope between young and old adults suggesting that the encoding processes of the older group of adults were slower than the encoding of the young adults. One interpretation of these results is that encoding is not a completely automatic process. Kirsner and Sang (1979) have challenged the traditional interpretation of Posner (1978) that an acoustic code is automatically generated from visually presented letters. The results of Kirsner and Sang suggest that a visual code is generated automatically, but the generation of an acoustic code is an optional process. They have also presented support for the position that a visual code can be retained as long as four seconds.

There are several reasons to believe that there might be age differences between visual and acoustic encoding. Visual perception has in general been found to be slower in old adults than young adults (see Hoyer & Plude, 1980 for review). Although disputed by Walsh and Thompson (1978), there is support in the literature for an increased persistence of a visual image in older people (Kline & Orme-Rogers, 1978; Kline & Schieber, 1981), a condition that might result in delayed acoustic encoding. On the other hand, the current literature on aging suggests that age-related deficiencies in memory are greater for visuo-spatial information than for verbal information (Schear & Nebes, 1980; Winograd & Simon, 1980), suggesting that acoustic codes are the preferred modes of internal representation. Therefore, if as

Kirsner and Sang propose, the generation of an acoustic code is an optional process, older individuals might generate an acoustic code earlier than younger adults.

To summarize, the present study was an investigation of the time course of visual and acoustic encoding in young and old adults, using as stimuli visually and acoustically confusable pairs of letters. It was predicted that the intercept for the older age group would be greater than for the young group, reflecting generalized slowing in time for decision making and a motor response. It was also predicted that for the young group, the pattern of latencies for each condition across ISIs would replicate Thorson et al.'s (1976) findings: latencies would increase for acoustically confusable letter pairs and decrease for visually confusable letter pairs as a positive function of ISI. Because of conflicting results from earlier studies, the study was exploratory with respect to an age by confusability interaction. Parallel slopes for both age-groups, indicating no difference in encoding time, would support the position that encoding is an automatic process and that age-related slowing does not occur in automatic processes. For the older group, a more gradual decline in RT for visually confusable letters, and an increase in RT for acoustically confusable letters starting at a longer ISI would support increased persistance of a visual code, and a delayed generation of an acoustic code. A steeper drop for visually confusable letters and an increase in RT for

acoustically confusable letters starting at a shorter ISI would support a nonautomatic earlier generation of an acoustic code.

Method

Subjects

Subjects were 15 men and 15 women in each of two age-groups: young ($\bar{X}$ = 21.4, range = 18-24) and old ($\bar{X}$ = 68.8, range = 65-76). The young group was composed of college stdents. They received class credit for participation. Subjects in the old group were recruited through community organizations. All were in good health, living independently in the community, and were high school graduates. They were paid $3.00 for participation in the study.

Stimuli

Stimuli were the pairs of visually and acoustically confusable letters used by Thorson et al. (1976). Visually confusable letter pairs were: PR, EP, XY, MW, YV, and KX; acoustically confusable letter pairs were ED, EP, FS, NA, PQ, AND XS. In order to have an equal number of matched and unmatched pairs, 12 pairs of identical letters were also presented. These were YY, PP, DD, KK, OO, EE, FF, AA, RR, XX, MM, and SS. Stimuli were prepared by stenciling 1.1 cm. block letters on white cards.

Research Design

A 2 x 2 x 6 mixed factorial design was used with age group as the between-subjects factor. The within-subjects factors were

ISI and confusability. Each pair of letters was presented under each of the six ISIs, 0.0, 0.5, 1.0, 1.5, 2.0, and 2.5 seconds. Order of presentation of stimuli and of ISIs was randomized for each subject.

Procedure

The entire set of 144 stimuli was presented to each subject using a three-field tachistoscope. The subject first saw a fixation point, which was followed by a 0.5 second presentation of the first stimulus, an ISI of variable duration, and finally a 0.5 presentation of the second stumulus. The fixation point was present during the ISIs and between stimulus pairs. Before each pair of stimuli, the subject was given a verbal cue. Subjects were instructed to rest the finger of the preferred hand on a center white dot and to push the left knob if the letters were the same and the right knob if they were different. Errors and RT were recorded.

Results

Errors were few (< .007% for the young group and < .01% for the old group). In order to provide an equal number of responses for each condition, the mean for a subject's responses in the same subcondition was substituted for an error score. The RT's for matched pairs were not included in the analysis. As no significant differences were found between men and women, scores were collapsed across sex. The data were analyzed with an analysis of variance.

Significant main effects were found for age group, ($F(1,58) = 4.27$, $p < .05$) and for ISI, ($F(5,290) = 16.84$, $p < .001$). Also the interaction between age group and confusability was significant, ($F(1,58) = 9.75$, $p < .005$). Figure 1 indicates that (except for ISIs of 2.5 seconds) RTs for the old group were consistently higher when the stimuli were visually confusable, while the young group showed little difference in latencies between the two conditions.

Discussion

As predicted, the older subjects were slower in their responses. However, the results of Thorson et al. (1976) were not replicated for either age-group. For both groups in both conditions, there was a sharp drop in RT between 0.0 and 0.5 seconds, the high RT at an ISI of 0.0 seconds presumably reflecting the sum of encoding times for the two stimuli. For the young group, there was essentially no difference between the slopes of the two types of letters, and the slopes were almost flat between 0.5 and 2.5 seconds. Only at 2.0 seconds was there a decrease in RT for visually confusable letters, suggesting the predominance of a visual rather than an acoustic code.

For the older group, slopes in the two confusability conditions were parallel except for an ISI of 2.5 where they converged. RTs declined from 0.0 to 1.0 seconds and then rose to 2.5 seconds, but the changes in slope were very gradual compared with those of Thorson et al (1976). The most interesting result,

one that was not predicted, was that across all ISIs, RTs were consistently higher for visually confusable letters than for acoustically confusable letters. The one exception was at 2.5 seconds where RT's of the two conditions converged. Although a decline in visual acuity may have resulted in a less clear or a less accurate visual representation for the older group, the very small number of errors suggests that this was not the sole explanation.

Results suggest that for older subjects, the visual code was predominant for ISIs as long as 2.0 seconds. This may be in part accounted for by an increased persistance of a visual image for the older subjects, as proposed by Kline and his colleagues (Kline & Orme-Rogers, 1978; Kline & Schieber, 1981). Kirsner and Sang (1979) found that although the visual code could persist as long as 4 seconds, its accessibility decreases with increasing ISI's. Their results suggest that attention to the visual code delays the assessibility to an acoustic code, but does not improve accessibility to the declining visual code. Results of the present study were consistent with this position and suggest that in older subjects, prolonged attention to the visual code longer subjects may have interfered with the optional generation of an acoustic code. Previous studies (Arenberg, 1977; Clarkson-Smith & Halpern, 1983) have reported that providing verbal labels enhanced the visual memory of older adults more than of younger adults, suggesting that older people are less

likely to spontaneously generate verbal codes. It has also been shown that older people are less likely than younger ones to form visual images from verbal material (Nebes & Andrews-Kulis, 1976). Therefore, the difficulty experienced by older people appears not be in the form of the internal representation but in the ability to transfer information from one form of internal representation to another. In contrast, younger subjects appear to have more readily generated an acoustic code, and having had both codes available to them were able to use the more appropriate one.

To summarize, the findings of Thorson et al. (1976) were not replicated for either age group. Results of the present study support Kirsner and Sang's (1979) position that generation of an acoustic code is an optional rather than an automatic process. Results suggest that there are strategy differences in encoding between young and old adults, and that in contrast to young adults, older adults are deficient in the generation of an acoustic code due to persisting attention to a visual code.

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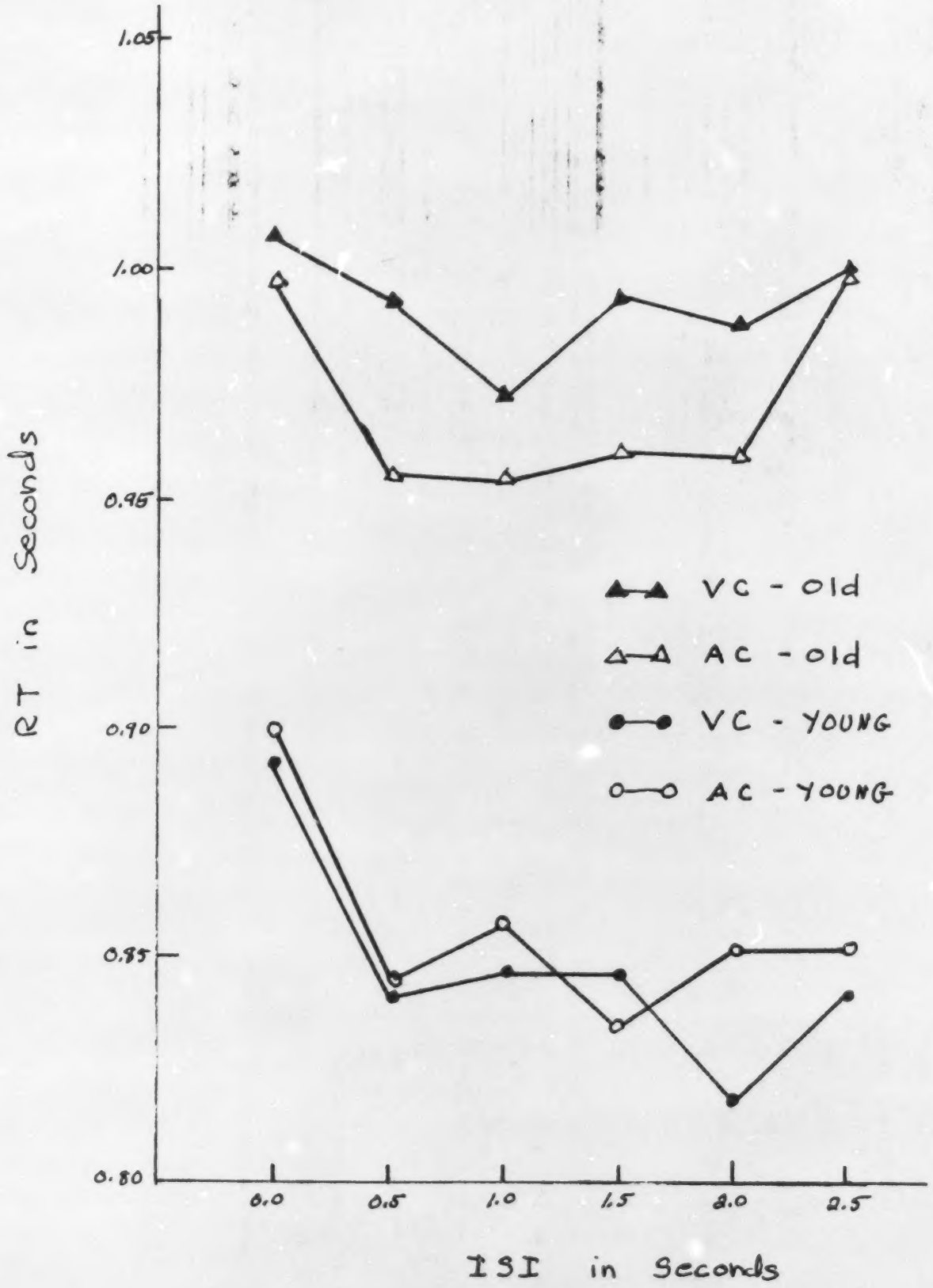
Figure Caption

Figure 1. Mean RT as a function of age, ISI, and confusability.


1.05
1.00
0.95
0.90
0.85
0.80
RT in Seconds
VC - Old
AC - Old
VC - YOUNG
AC - YOUNG
0.0
0.5
1.0
1.5
2.0
2.5
ISI in Seconds